REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	6/22/98	FINAL / 10/01/94 - 11/30/96

4. TITLE AND SUBTITLE
Distribution, Abundance, and Growth Rates of Phytoplankton in the California Coastal Zone

5. FUNDING NUMBERS
ONR
N00014-95-1-0017

6. AUTHOR(S)
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8. PERFORMING ORGANIZATION REPORT NUMBER

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10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Unrestricted

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Pigments associated with microalgae are one of the most important factors absorbing light in the ocean. Yet, the dynamics of these pigments in the ocean and factors controlling their distribution and rates of change are little known. We studied the abundance and growth rates of micoalgal taxa in the California Coastal Zone to elucidate the factors controlling these and their associated pigments. The methods we used were primarily pigment-based. The composition of the phytoplankton community was dominated by eucaryotes close to shore and by cyanobacteria, particularly Prochlorococcus, offshore. Growth rates of these different groups were highly variable, ranging from low values of 0.25d-1 in nutrient depleted offshore areas to 1.8d-1 in upwelling areas dominated by diatoms. Growth rates of most other taxa under nutrient replete conditions only reached values of 0.6 to 0.9 d-1, suggesting that maximum growth rates of these different taxa differ significantly. Results of nutrient enrichment experiments suggest that phytoplankton growth is often limited by the availability of inorganic nitrogen in the offshore areas of the California Coastal Zone.

14. SUBJECT TERMS	15. NUMBER OF PAGES
California Current, phytoplankton, growth rates, pigments	4
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unrestricted	Unrestricted	Unrestricted	None

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SUBJECT: Final Technical Report
ONR Award No. N00014-95-1-0017
PI: Dr. Ralf Goericke, Assistant Research Oceanographer

Enclosed for your records is the final technical report for the above referenced grant.

Sincerely,

Linda M. Ford
Contract & Grant Assistant

FINAL REPORT

ONR AWARD: N00014-95-1-0017

TITLE: Distribution, Abundance, and Growth Rates of Phytoplankton in the California Coastal Zone

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SS# 027-64-2311

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ABSTRACT

Pigments associated with microalgae are one of the most important factors absorbing light in the ocean. Yet, the dynamics of these pigments in the ocean and factors controlling their distribution and rates of change are little known. We studied the abundance and growth rates of micoalgal taxa in the California Coastal Zone to elucidate the factors controlling these and their associated pigments. The methods we used were primarily pigment-based. The composition of the phytoplankton community was dominated by eucaryotes close to shore and by cyanobacteria, particularly *Prochlorococcus*, offshore. Growth rates of these different groups were highly variable, ranging from low values of $0.25d^{-1}$ in nutrient depleted offshore areas to $1.8d^{-1}$ in upwelling areas dominated by diatoms. Growth rates of most other taxa under nutrient replete conditions only reached values of 0.6 to 0.9 d^{-1}, suggesting that maximum growth rates of these different taxa differ significantly. Results of nutrient enrichment experiments suggest that phytoplankton growth is often limited by the availability of inorganic nitrogen in the offshore areas of the California Coastal Zone.

LONG-TERM GOALS:

We study phytoplankton community structure and taxon-specific growth rates of phytoplankton in the ocean using primarily pigment-based methods. It is our goal over the next decade to characterize different biogeochemical provinces and contribute to an understanding of the factors that limit phytoplankton growth in the world's ocean. This research is aimed at understanding and predicting the effects of phytoplankton on the dynamics of optical fields in the coastal and open ocean.

SCIENTIFIC OBJECTIVE:

We have studied the California Coastal Zone, where many physio-chemical factors that affect phytoplankton growth vary significantly along sections perpendicular to the coast-line. It is anticipated that we will be able to identify the dominant factors that regulate taxon-specific growth by relating rates of growth to environmental

variables. It is hoped that such a data set will elucidate the factors that control the composition of phytoplankton communities in this marine environment.

APPROACH:

Phytoplankton community composition was studied using taxon-specific pigments (chlorophylls and carotenoids). Taxon-specific growth rates were determined from the incorporation of inorganic carbon-14 into taxon-specific pigments (pigment-labeling method). In addition we studied the response of the phytoplankton community to nutrient additions in incubation bottles. Short-term responses were characterized using fluorescent techniques and long term responses were characterized using changes in pigment concentrations and flow-cytometric signatures (in collaboration with J. Collier, SIO). Ancillary to this project we have studied the pigments in sediments from the Southern California Bight and in particular the Santa Barbara Basin.

TASKS COMPLETED:

We have participated on five CalCOFI cruises and one shorter cruise off San Diego. The aim of the latter cruise was to study a dinoflagellate bloom in La Jolla Bay, particularly the photoadaptive response of dinoflagellates to light stress in the surface layer. In the laboratory we have analyzed pigment samples from all our cruises and processed samples for the analysis of carbon-14 labeled pigments for growth rate measurements.

SCIENTIFIC RESULTS:

The analysis of our data has revealed some very interesting patterns in the abundance of different groups of phytoplankters in the California Current System. The abundance of *Prochlorococcus sp.* along some CalCOFI lines is independent of variations of total phytoplankton biomass, suggesting that this organism does not respond to nutrient enrichments as other phytoplankters. Phytoplankton growth rates varied dramatically from high values close to the coast - with the exception of declining blooms - to low values offshore. High values offshore were at times associated with meso-scale features (likely eddies). Taxon-specific growth rates varied significantly; whereas growth rates of prymnesiophytes, pelagophytes and prochlorophytes only reached values of ~0.7 d^{-1} under nutrient replete conditions, growth rates of diatoms and sometime cyanobacteria reached values of 1.2 to 1.8 d^{-1}. Nutrient enrichment experiments suggest that a large component of the community is nitrogen limited in stratified offshore waters. Our studies of the sediments of the Southern California Bight and the Arabian Sea has lead to the discovery of a new type of chlorophyll a degradation product (a pyropheophorbide a carotenoid ester). This pigment was also found in water column samples dominated by diatoms.

SIGNIFICANCE:

Our results have shown that 'the phytoplankton' in any one area is not only a diverse assemblage but that the different groups of microalgae present are physiologically

distinct, characterized by dramatically varying growth rates and different responses to the physical and chemical environment. It is the implication that to understand or model phytoplankton - be this in an ecosystem or an optical context - phytoplankton can not be assumed to be a single component, a black box, but must be conceptualized as a diverse assemblage. Characterizing the members of this assemblage and their interaction with the environment to the extend that we can model these individually is the challenge for the future.

PERSONNEL / EDUCATION:

The award supported a post-doc, Dr. Miguel Olizola and two summer student fellows, Brian Saltzman (Univ. California, Davis) and Jessica Davis (La Jolla High School).

PUBLICATIONS AND PRESENTATIONS:

Olaizola, M., J. Collier, R. Goericke, 1995, Phytoplankton pigments, flow-cytometry and fluorescence analysis in the context of the CalCOFI program. CalCOFI conference 1995, Lake Arrowhead, CA.

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